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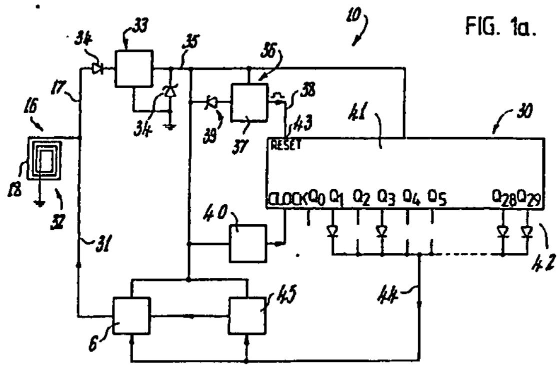
(58) Field of search
H4L

(54) Identification device

(57) An electronic identification transmitting tag, Fig. 1a, for carrying by a human or animal or inanimate object, is presented at an identification station where interrogation apparatus 11, 12, Fig. 1, transmits energy which is collected to power the tag circuits. The frequency of the interrogate signal is divided to provide clock and carrier frequencies, the clock signals being applied to a ripple counter 41 having selected outputs connected to an output line so as to provide an identity data pulse train. The identity signal gates the carrier frequency signal to a transmitter 32. The signal transmitted is at a fundamental carrier frequency and at sub-harmonics of that frequency. A signal receiver 13 applies the harmonic rich signal received to phase lock loop detectors 52 tuned to the fundamental and various harmonics so that simultaneous detection of the same signal enables verification of the information transfer operation. One possible tag includes temperature sensing and temperature data transmitting capabilities, e.g. for animal body temperature monitoring.

FIG. 1a.



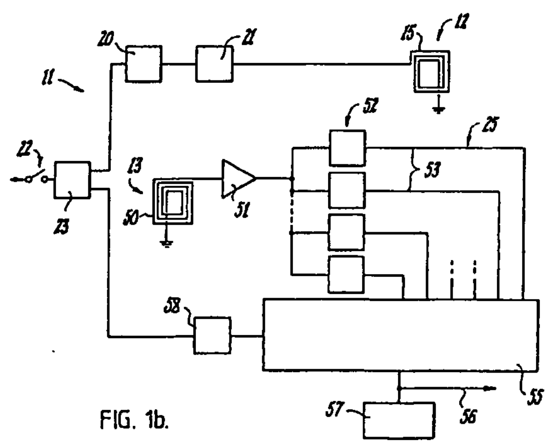


FIG. 1b.

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The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

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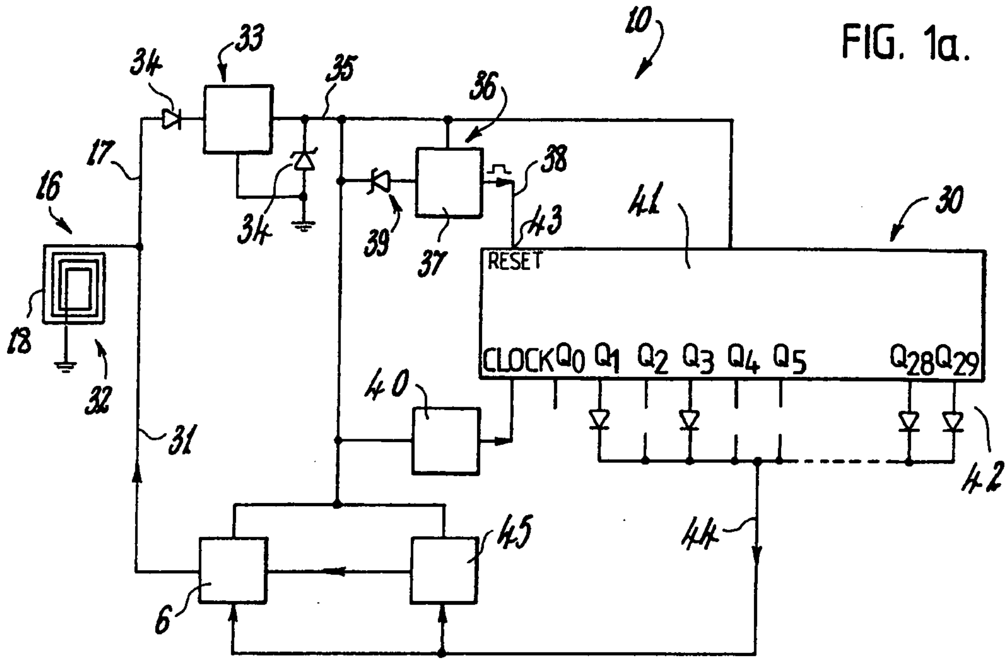

FIG. 1a.

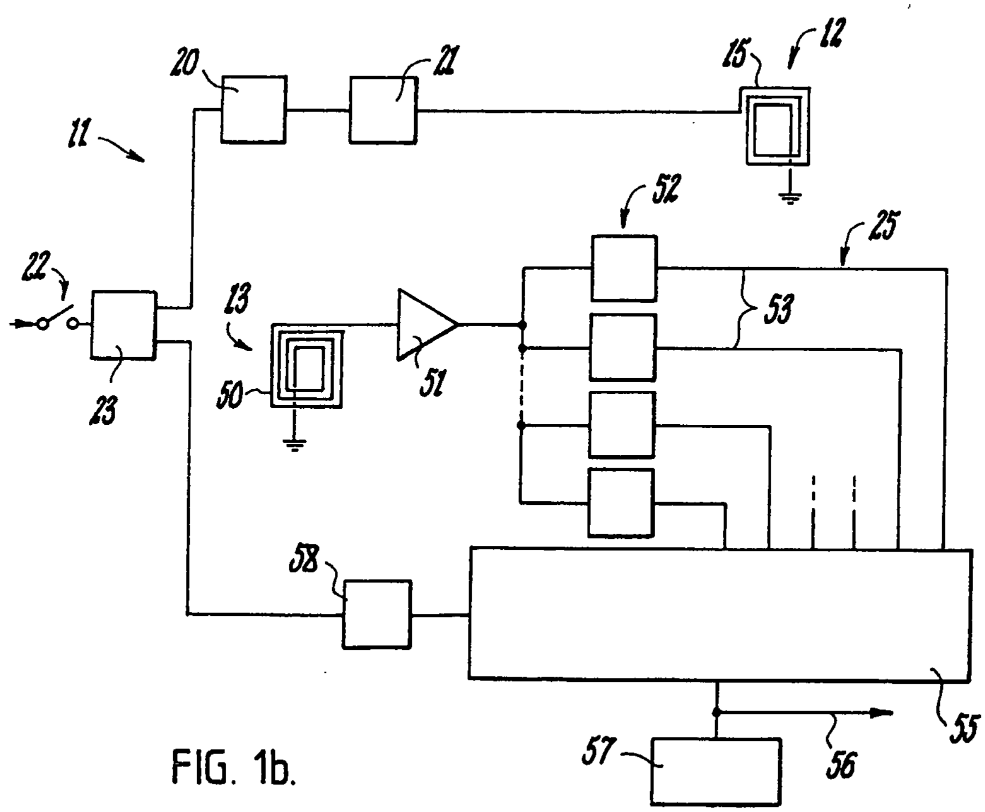

FIG. 1b.

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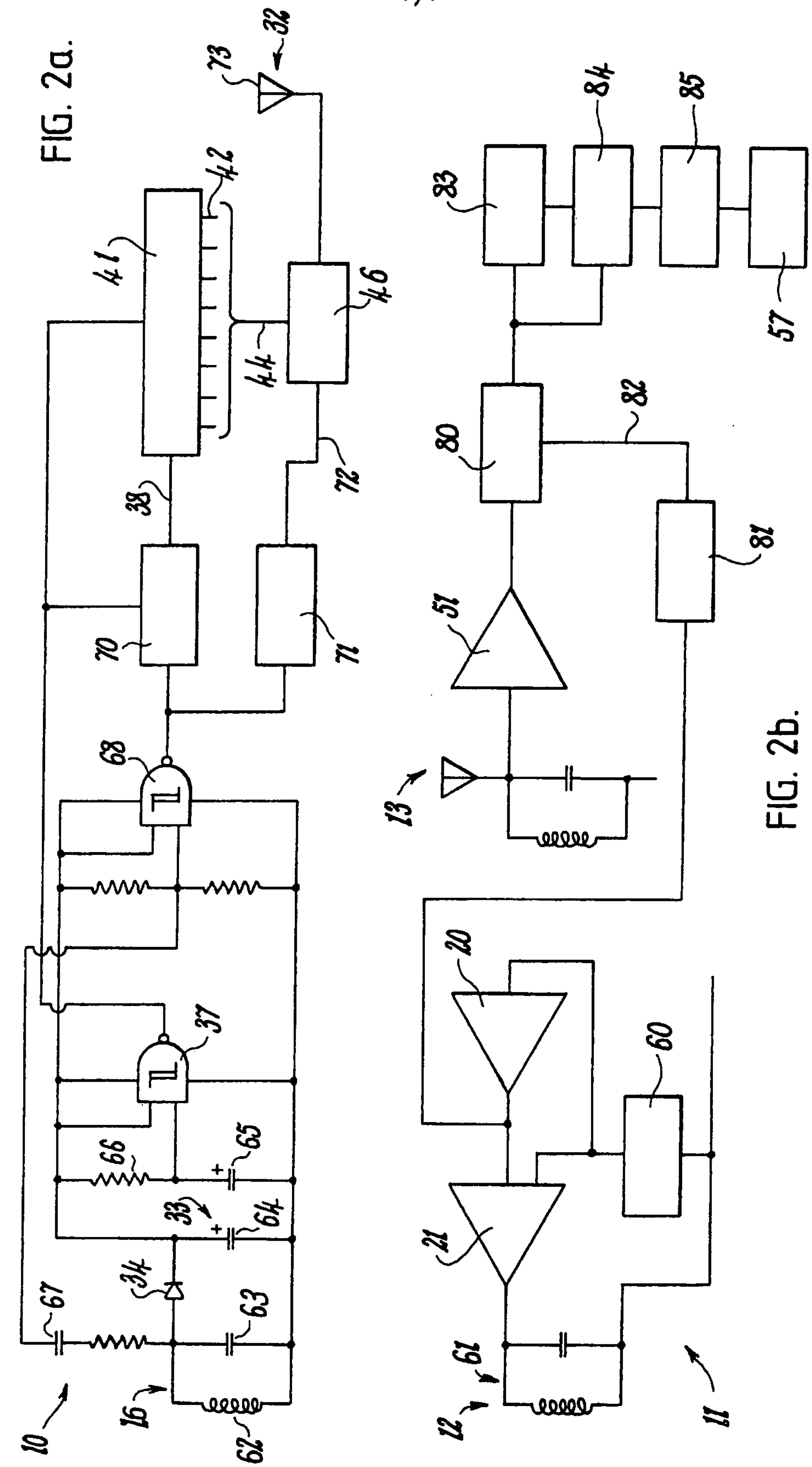

FIG. 2a.

FIG. 2b.

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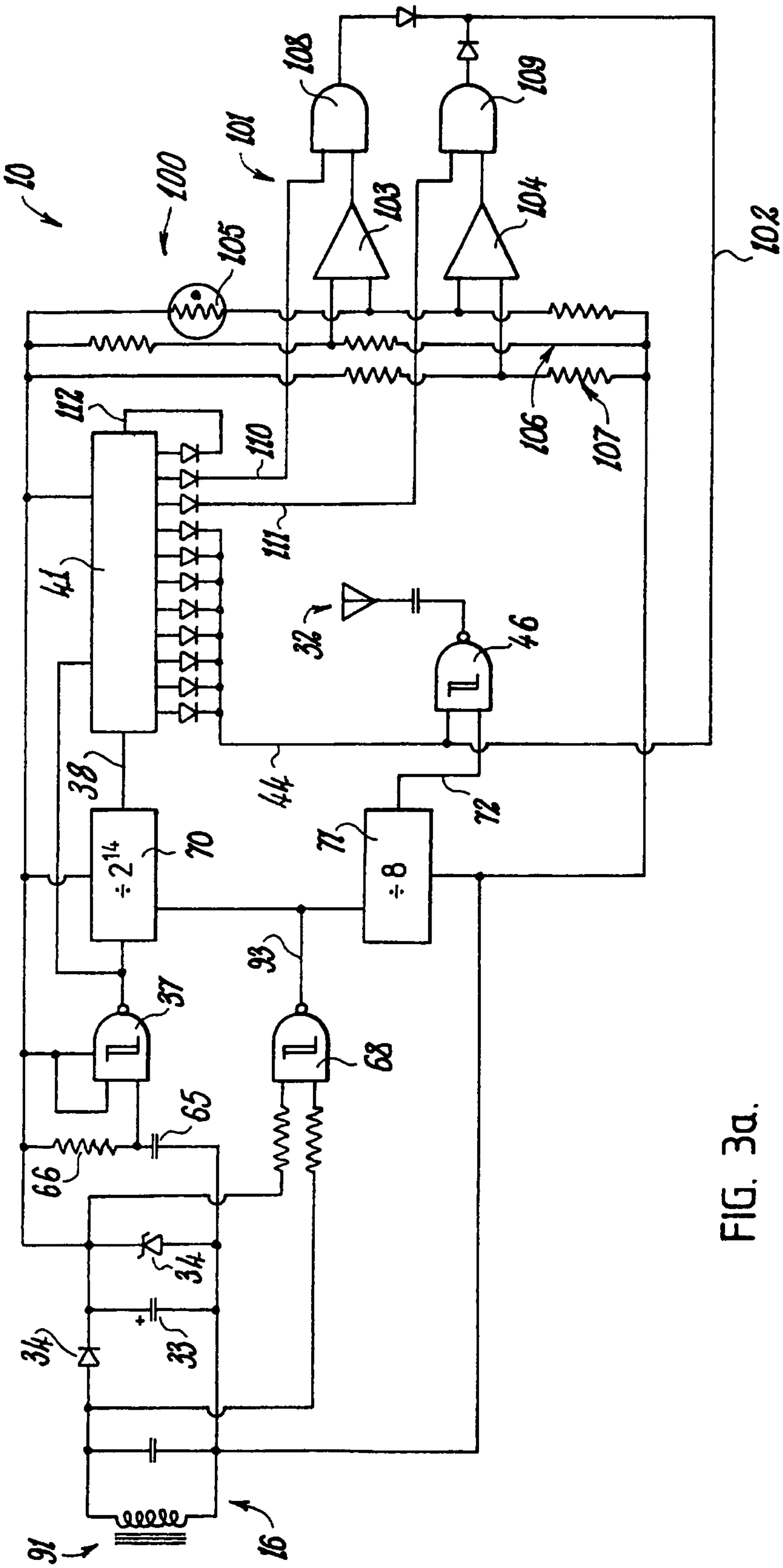

FIG. 3a.

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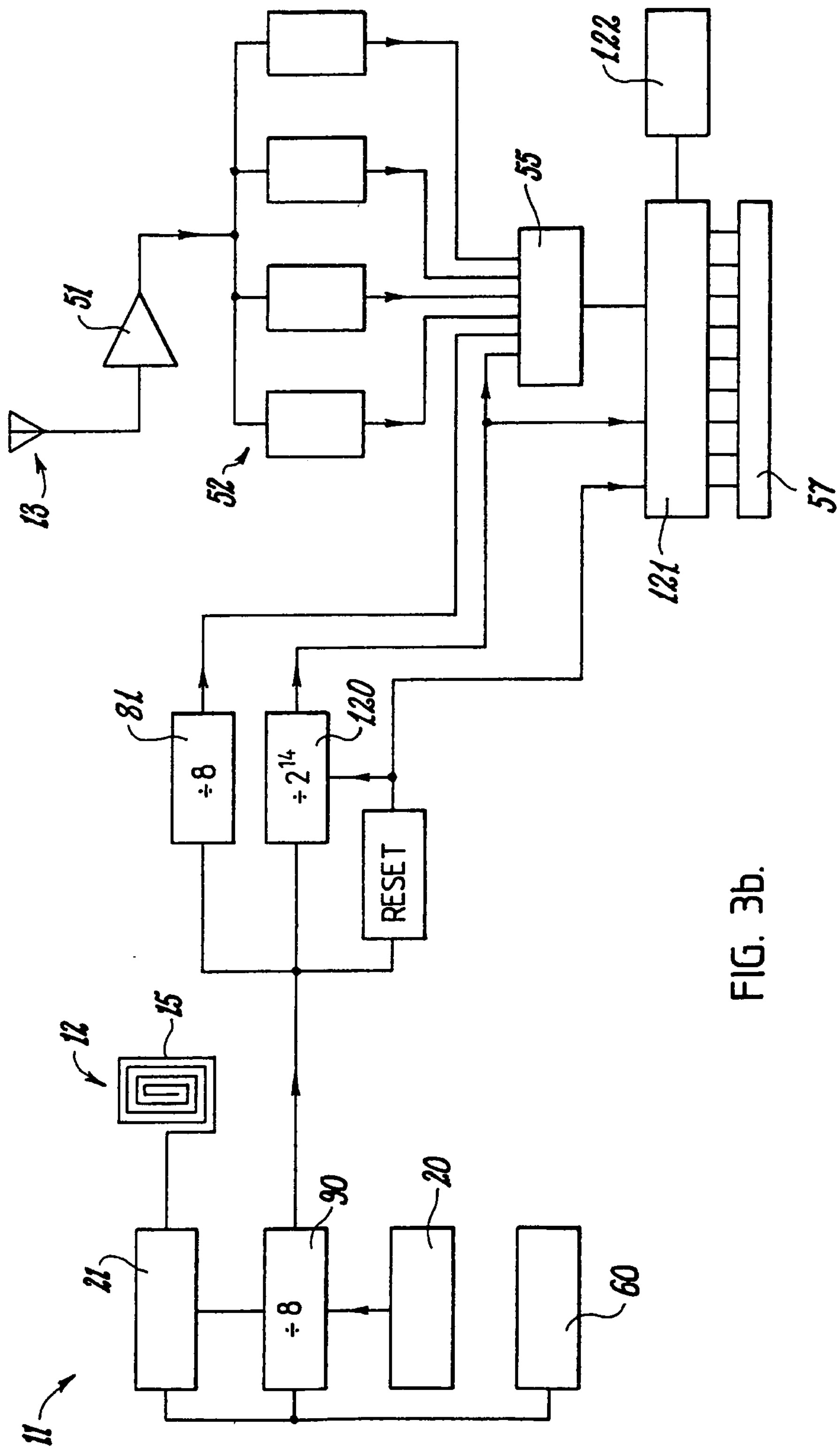

FIG. 3b.

SPECIFICATION

Identification device

This invention relates to an information transmitting identification device enabling identification of the device or a bearer of the device or transmittal of information concerning the environment or bearer of the device. For example, the device may be borne by a human, animal or an object and the device can provide a means of identifying the individual bearer for example amongst a population of humans, animals or articles. The device may also provide a means of conveying information concerning the bearer such as medical details of a patient, body temperature of an animal, lading data concerning an article, baggage claim information. Other uses for the device in which information is transferred may also be envisaged.

Previous solutions to the problem of identification of the bearer have involved the use of markings or labels bearing visible or sometimes magnetic indicia, symbols or numerals to provide a uniquie identification to an observer. A recent solution is the universal product code which requires manual operation of a scanning device to ensure accurate identification of an article to which a code lable is attached. These known solutions have required some manual operation such as reading or inspection of the device or precise location of the device at a clearly defined identification station.

It is an object of the present invention to provide an information transmitting identification device to be presented at an identification station to enable information concerning the characteristics or identity of the device or a bearer of the device and which does not need a manual operation such as reading or inspection of the device for information transmittal purposes.

It is a preferred object of the present invention to provide an identification device which does not need to be presented at a precise location for information transfer purposes and which will allow transfer of information at a distance of, say, one meter as the device is in motion and without the need for manual intervention in the information transfer operation.

According to the present invention there is provided an information transmitting identification device presentable at an identification station to enable reception therefrom of information concerning the device or a bearer of the device, the identification device being usable with interrogation apparatus for initiating an information transfer operation, the interrogation apparatus including: energy transmitting means for transmitting energy in the region of the identification station, a signal receiver at the identification station for receiving from the identification device an information signal comprising signal components, each signal component having a different respective frequency, the identification device including: energy collecting means operative to collect energy from the energy transmitting means and intercepted thereby in the region of the identification station and to generate an electrical power signal, information signal generating means operative to generate when energised from the electrical power signal an information signal comprising at least two carrier signals at respective predetermined carrier frequencies, each carrier signal being modulated in a coded way so as to be indicative of the information to be transmitted, and a signal transmitter operable to transmit the information signal to the signal receiver of the interrogation apparatus. The use of energy collecting means in the identification device enables the device to transmit the information signal to the interrogation apparatus without the need for precise positioning of the identification device and without the need for manual scanning of the device or machine scanning under manual control. Also, the provision of the information signal comprising at least two carrier signals at differing frequencies enables ready verification of the information transferred, in spite of, for example, the possibility of external interference at one of the carrier frequencies.

The information signal generating means may include a carrier oscillator operable at a fundamental frequency, the carrier oscillator being arranged to be over-driven in use so as to generate a main carrier frequency signal at said fundamental frequency or at a harmonic of said fundamental frequency, and also so as to generate a further one of the at least two carrier signals at a sub-harmonic of the main carrier frequency.

In an alternative possible arrangement, the information signal generating means may include a square wave generator operable at a fundamental frequency, the wave generator operable at least two carrier signals at respective predetermined carrier frequencies comprising a main carrier frequency generated by the square wave generator and at least one secondary carrier frequency signal generated at a sub-harmonic of the main carrier frequency by the square wave generator, the main carrier frequency being equal to or being a subharmonic of the fundamental frequency of the square wave generator.

The energy transmitting means may be operative to transmit energy at a predetermined interrogate frequency and the main carrier frequency may be a sub-harmonic of the interrogate frequency. In this particular embodiment, the information signal generating means may include dividing means for receiving a signal at the interrogate frequency from the energy collecting means, the dividing means being operative to divide the interrogate frequency so as to provide an output at the main carrier frequency and which is used to generate the carrier signals.

The mode of coding the information may involve providing gating means as part of the information signal generating means, the gating means being operative to gate the carrier signals to the signal transmitter, the pattern of gating constituting a coding of the information to be transmitted.

The present invention also provides an information transfer apparatus including an information transmitting identification device according to the

invention and an interrogation apparatus including energy transmitting means and a signal receiver. The signal receiver may include a plurality of detectors, each being operable at a respective one of the carrier frequencies, the signal receiver further including indicating means coupled to the detectors and operative to indicate when a plurality of the detectors detect the simultaneous receipt of carrier signals modulated in the same coded way so as to be indicative of the same information having been simultaneously transmitted by the identification device at more than one of the carrier frequencies.

According to the present invention there is also provided an information transmitting identification device presentable at an identification station to enable reception therefrom of information concerning the device or a bearer of the device, the identification device being usable with interrogation apparatus for initiating an information transfer operation, the interrogation apparatus including: energy transmitting means for transmitting energy at a predetermined interrogate frequency in the region of the identification station, a signal receiver at the identification station for receiving from the identification device an information signal comprising a signal component having an information frequency, said information frequency being a subharmonic of said interrogate frequency, the identification device including: energy collecting means operative to collect energy from the energy transmitting means and intercepted thereby in the region of the identification station and to generate an electrical power signal, information signal generating means operative to generate when energised from the electrical power signal an information signal comprising a carrier signal at said information frequency, said carrier signal being modulated in a coded way so as to be indicative of the information to be transmitted, and a signal transmitter operable to transmit the information signal to the signal receiver of the interrogation apparatus. Again, the use of energy collecting means enables the device to transmit an information signal without the need for precise positioning or manual scanning or machine scanning under manual control. The provision of the carrier signal at a sub-harmonic of the interrogate frequency enables synchronous operation of the interrogation apparatus and the identification device, largely independent of temperature variations which may effect the frequency of the signals being transmitted.

The information signal generating means may include dividing means for receiving a signal at the interrogate frequency from the energy collecting means, the dividing means being operative to divide the interrogate frequency so as to provide an output at the information frequency and use to generate the carrier signal.

Preferably, as with the first embodiment, the information signal generating means is also operative to generate at least one further carrier signal at a further information frequency being a sub-harmonic of the main information frequency, the furthe carrier signals being modulated in the same coded way so as to be indicative of the information being transmitted.

In either embodiment of the identification device according to the invention, the information signal generating means may include a clock generator supplying a clock signal at a clock frequency and a counter coupled to receive the clock signal, the counter having a plurality of outputs which provide a signal sequentially at the clock frequency. A predetermined sequence and number of the outputs are connected to an output line so that a pulse train indicative of the particular sequence and number of connected outputs will be produced on the output line, the pulse train representing the information to be transmitted.

The energy transmitting means may be operative to transmit energy in the region of the identification station for a predetermined time interval, the identification device including delay means coupled to the information signal generating means, the delay means being operative to inhibit operation of the information signal generating means until the end of the time interval.

In one possible use of the identificate device, the device may include a temperature sensor for sensing a temperature associated with a bearer of the device, such as the body temperature of an animal, and temperature encoding means coupled to the temperature sensor and operative to generate a coded temperature signal indicative of the temperature sensed, the coded temperature signal being applied to the information signal generating means so that the information signal includes information relating to the temperature sensed.

The identification device according to the invention may be used in an identification or other information transfer apparatus, the apparatus including an interrogation apparatus as previously outlined and at least two of the identification devices. Each of the identification devices may be operative to generate a unique and respective identification signal. For the purposes of distinguishing between different identification devices, and hence between the bearers of those devices, the interrogation apparatus may include identification circuitry for generating an appropriate output signal upon receipt of the information signal by the signal receiver.

The present invention will be further described with reference to the accompanying drawings which illustrate possible preferred embodiments of the invention. However, it will be appreciated that the particular features of the circuits illustrated in the accompanying drawings are not limiting on the present invention. In the drawings:

Figure 1A shows a first possible embodiment of an identification device according to a preferred embodiment of the present invention,

Figure 1B is an interrogation apparatus usable with the device of Figure IA,

Figure 2A is a diagram of a second possible embodiment of a device according to a preferred embodiment of the present invention,

Figure 2B is a circuit diagram of an interrogation apparatus usable with the device of Figure 2A,

Figure 3A is a circuit diagram of a third possible

preferred embodiment of a device according to the present invention,

Figure 3B is a diagram of an interrogation apparatus usable with the identification device of Figure 3A.

Referring now in detail to the embodiment shown in Figures IA and IB, the identification device 10 is usable with the interrogation apparatus 11 which, in use, would be located at an identification station. The interrogation apparatus 11 includes energy transmitting means 12 for transmitting energy in the region of the identification station and a signal receiver 13 for receiving from the identification device 10 an information signal. The transmitting means 12 is operable to generate an electro magnetic field which may be of alternating direction.

The energy transmitting means 12 may comprise an inductor coil 15 as illustrated or may be an antenna. In the case of inductor coil 15 being used, the coil 15 when energised will generate a magnetic field at the identificate station and the identification device 10 may be passed through the coil 15 or in the vicinity of the coil 15 to intercept the field generated. Similarly, if an antenna is used, the antenna will generate an electro-magnetic field or radiation in the region of the identification station and which is intercepted by the energy collecting means 16 of the identification device 10.

The energy collecting means 16 is operative to collect energy from the energy transmitting means 12 and intercepted thereby in the region of the identification station and to generate an electrical power signal on line 17.

In the case where inductor coil 15 is used as the energy transmitting means 12, the energy collecting means 16 of the identification device 10 comprises a receiving inductor 18 or antenna arranged to cross or intercept the field generated so that a current will be induced in the receiving inductor 18 or antenna, the current induced constituting the electric power signal on line 17.

The power supplied to the energy transmitting means 12 is generated from an oscillator 20, the output of which is passes through a power amplifier 21 and thence to the inductor 15 or antenna. The generation of the energy or field at the identification station by the energy transmitting means 12 need not be continuous. In fact, it is preferred that the energy transmitting means 15 is under switched control 22. The switching of power to the energy transmitting means 12 to create the field may be under manual control of an operator at the identification station. Alternatively, the switching of power to the energy transmitting means 12 may be under automatic control. For example, when the identification device 10 is presented at the identification station by a human bearer, the Interrogation apparatus 11 may be actuated to supply power to the energy transmitting means 15. Alternatively, in the case of animals or inanimate articles being conveyed, say, along a defined path or corridor, a photocell or other such presence detector (not shown) may be provided to initiate closing of switch 22 thereby supplying power to the energy transmitting means 15 when the animal or article reaches the identification station. The switching of power to the energy transmitting means 15 may be under the control of a timer 23 so that the generation of the field by the transmitting means 12 can be for a predetermined time interval sufficient for the energy collecting means 16 of the identification device 10 to collect sufficient energy to operate the remaining components of the identification device 10. When the timer 23 is operational and power is being supplied to the energy transmitting means 15, the timer 23 may also be operable to disable the identification circuitry 25 of the interrogation apparatus 11 as will be further described hereinafter.

As mentioned above, the energy collecting means 16 of the identification device 10 may comprise a receiving inductor 18 or antenna. In the case of an alternating field generated by the transmitting means 12, an AC current will be induced in the energy collecting means 16 of the identification device 10 when the field is being intercepted by the inductor 18 or antenna in the vicinity of the identification station.

The identification device 10 includes information signal generating means 30 operate to generate when energised from the electrical power signal on line 17 an information signal on line 31. The information signal 31 comprises at least two carrier signals at respective predetermined carrier frequencies, each carrier signal being modulated in a coded way so as to be indicative of the information to be transmitted. The mode of generation of the carrier signals and coding will be described later. The information signal on line 31 is passed to signal transmitter 32 (constituted by the energy collecting means 16 in this embodiment) and which is operable to transmit the information signal to the signal receiver 13 of the interrogation apparatus 11.

The identification device 10 includes energy storage means 33 for the purpose of storing sufficient energy for operation of the remainder of the circuitry of the identification device 10 while the device is at the identification station and is intercepting the field. The energy storage means 33 may comprise a capacitor connected so as to be charged when current is induced in the energy collecting inductor 16 or antenna. The AC current induced in the inductor 16 or antenna in the preferred embodiment is rectified such as by a full-wave rectifier or by a single diode 34 providing half-wave rectification, the rectified voltage being applied to the capacitor 33 to charge the same. The energy storage means 33 also includes a charge limiter 34 operable to limit the charge developed on the capacitor. The charge limiter 34 comprises a zener diode which is connected in reverse mode across the capacitor, the reverse breakdown voltage of the zener diode 34 being chosen to limit the voltage developed to the maximum safe working voltage of the identification device components. That is, the charge limiting zener diode 34 limits the supply voltage which is provided on line 35 for the identification device 10. The energy storage means 33 is

connected to the identification signal generating means 30 so as to supply power for operation.

The identification device 10 also includes transmission delay means 36 operable to prevent operation of the identification signal generating means 30 for a predetermined time. In particular, the transmission delay means 36 is operable to disable or inhibit the identification signal generating means 30 until the energy transmitting means 12 ceases to transmit energy at the identification station. The transmission delay means 36 comprises a signal generator 37 operable to hold the identification signal generating means 30 in a standby condition until the cessation of energy transmission. The signal generator 37 comprises a reset signal generator operative to generate a reset or standby pulse on line 38, the duration of the pulse being chosen so that the energy transmitting means 12 will be switched off under the control of the timer 23 of the interrogation apparatus 11 before the identification signal generating means 30 is operated to generate the information signal on line 31. The reset signal generator 37 is operated by means of a grigger 39 which is actuated when the energy storage means 33 has stored a predetermined amount of energy (less than the limit set by the charge limiter 34). The trigger 39 comprises for example a reverse connected zener diode coupled between the energy storage means 33 and the reset signal generator 37, the trigger zener diode 39 having a reverse breakdown voltage selected to be above the minimum operating threshhold of the circuit components of the identification device 10. With this arrangement, when the voltage on the capacitor constituting the energy storage means 33 reaches the breakdown voltage of the trigger zener diode 39, the reset signal generator 37 is operated to generate a one shot reset or standby pulse of the predetermined duration, that pulse being applied to the identification signal generating means 30 to hold that device inoperative (but in its reset condition).

The identification signal generating means 30 of the identification device 10 comprises a coded signal generator operative to generate the information signal on line 31 in coded form. The coded signal generator in Figure IA is preset or preprogrammed so as to generate a unique code for each identification device constructed according to the present invention. Of course, the coded signal generator could be programmed to generate the same coded identification signal in a number of identification devices, such devices being adapted to be used with identical or similar bearers such as identical products to be identified upon being presented at the identification station. Also the information signal may include variable coded information provided by, say, a sensor associated with the device such as a body temperature sensor.

Preferably, the coded information signal is a signal in binary notation. For this purpose, the identification signal generating means 30 includes a clock oscillator 40 operable at a predetermined clock frequency, the clock oscillator 40 being supplied with power from the energy storage means 33. The coded signal generator comprises a ripple counter 41 having a plurality of outputs 42, the arrangement being such that the appearance and sequence of signals on selected ones of the counter outputs represents the information to be transmitted. The ripple counter 41 is arranged to be held disabled by the transmission delay means 36 until the energy transmitting means 12 has been de-energised. In the particular embodiment illustrated, the reset signal generator 37 constituting the transmission delay means 36 has its output connected to the reset input 43 of the ripple counter 41. The ripple counter 41 may comprise, say, a thirty stage Johnson ripple counter having selected ones of its outputs 42 coupled to an output line 44 so as to provide in operation a pulse train output representing a binary number. Selected ones of the outputs 42 of the ripple counter 41 are open circuited whilst the connected outputs are connected to the output line 44 through diodes.

Considering the thirty outputs of the Johnson ripple counter 41 to be numbered Q0 to Q29, the first output Q0 is not connected to the output line 44 so that there would be no signal on that line 44 while the reset pulse is being applied to the reset input 43. The next four outputs of the ripple counter QI to Q4 may be coupled in the same way in every identification device according to the present invention, so as to provide a common validity signal as the first part of the information signal. For example, QI and Q3 are shown as being connected through diodes to the output line 44 and Q2 and Q4 are open circuited so that upon activation of the ripple counter 41 the first part of the information signal comprises a validity signal in the form of the binary number 1010. This common initial pattern for all identification devices is designed to facilitate valid signal identification by the interrogation apparatus 11. The remaining outputs Q5 to Q29 are active (high) when diodes are installed between the outputs 42 and the output line 44 and are inactive (low) when the outputs 42 are not connected to the output line 44. Thus, the remaining outputs Q5 to Q29 will provide a 24 bit binary code as an identification number signal following the validity signal, allowing 24 unique combinations of identification numbers.

The signal transmitter 32 of the identification device 10 includes a carrier oscillator 45 supplied with power from the energy storage means 33, and operable to generate a fundamental carrier frequency signal modulated by the signal on the output line 44. That is, the initial validity signal followed by the 24 bit identification number signal is used to modulate the carrier oscillator output. This oscillator 45 may be controlled by either a crystal or ceramic resonator to assure stable frequency operation over a wide range of supply voltages. The fundamental frequency of the carrier oscillator 45 is selected on the basis of economy and physical dimensions of the components. The carrier oscillator 45 is overdriven to produce a signal rich in harmonics thus producing a main carrier frequency signal at the fundamental frequency (or at a harmonic of the fundamental frequency) and

also to generate further carrier signals at sub-harmonics of the main carrier frequency. That is, the overdriven oscillator 45 will generate a comb of frequencies including many harmonics of the fundamental frequency. By this means, it is possible to provide up to ten or even more frequencies, any one of which can provide the identification signal at the signal receiver 13. The frequency of the oscillator 45 in practice would be chosen so as to be usable worldwide without jamming. This would normally require assignment of a clear channel to assure clear detection of the anticipated very small signal level. The output of the oscillator 45, modulated by the identification signal, is applied to a gate 46, powered from the energy storage means 33, to an antenna of the signal transmitter 32. The transmitting antenna 18 is shown as the same antenna used as the energy collecting antenna 18.

The identification device 10 may be provided in the form of a tag or card carrying the operational circuits, for example, as an integrated circuit.

The interrogation apparatus 11 in Figure IB and usable with the identification device 10 of Figure IA includes a signal receiver 13. The signal receiver 13 comprises a receiving antenna 50 operable to detect the information signal generated by the signal transmitter 32. The receiving antenna 33 may be any suitable component and the output of that antenna 33 is coupled to a wide band amplifier 51. The output of the amplifier 51 is connected to up to ten phase lock loop detectors 52, each providing detection of the carrier frequency or an individual respective harmonic of the carrier frequency. With this arrangement the signal receiver 13 is operable to detect up to ten of the radiated frequencies signals on respective input lines 53, each line carrying the information signal.

The identification circuitry 25 of the interrogation apparatus 11 includes a logic circuit 55 operable to identify the identification number in the signal received by the signal receiver 13. The logic circuit 55 is operable to identify both the validity signal constituted by the first four bits of the identification signal (1010), so that a valid identification signal can be recognised. The logic circuit 55 is also operable to discriminate the identification number. In order to achieve this descrimination, the logic circuit 55 is operable to compare the signals on the plurality of output lines 53 from the phase lock loop detectors 52 so as to recognise when the signals on at least two and preferably at least three of the phase lock loop output lines 53 are identical. That is, the logic circuit 55 is arranged to process the information signals at ten of the radiated frequencies and process them in a comparator section of the logic circuit 55 so as to respond when any three show the identical signal format simultaneously. The logic circuit 55 rejects all other signals which may include spurious jamming signals produced by other local services on any of the comb of frequencies transmitted.

The output of the logic circuit 55 may be processed in any desired manner. For example, the output signal representing the identification number of the particular identification device 10 may be passed on line 56 to a data recorder for transaction analysis for example. The signal may also be passed to a numerical display 57 for operator processing.

The identification circuitry as previously mentioned is disabled while the energy transmitting means 12 is energised. The timer 23 of the interrogation apparatus 11 is coupled to the logic circuit 55 of the identification circuitry through an enable circuit 58, so that the logic circuit 55 is held inoperative while the energy transmitting means 12 is energised.

In operation of the Figure IA and Figure IB system, an article bearing the identification device 10 may be travelling on a conveyor. When the article approaches or reaches the identification station, the energy transmitting inductor coil 15 is energised to set up an alternating field which is intercepted by the energy collecting inductor or antenna 18. The current induced is rectified and the capacitor 33 charges to a level set by the charge limiter 34. Before reaching that charge level, the transmission delay means 36 is activated to apply a reset pulse to the ripple counter 41, the duration of the reset pulse being sufficient to allow the field generation to be terminated under timer control before the ripple counter 41 becomes operational.

When the reset pulse ends the ripple counter 41 generates an output pulse sequentially at each of its output terminals at the clock frequency. Since only selected ones of the outputs 42 of the ripple counter 41 are connected to the output line 44, the signal on that line will comprise a binary coded number constituted by an initial 4 bit validity signal followed by a 24 bit identification number.

The signal on line 44 is used to gate the output of the overdriven oscillator 45 to the transmitting antenna 18.

The transmitted signal is received and amplified in the interrogation apparatus 11 and selected harmonics are isolated to provide a plurality of outputs on lines 53 which ideally will all carry the same identification signal.

The logic circuit 55 compares the signals received on the selected frequencies (harmonics) for concurrent reception of an identical signal at, say, three frequencies. Such concurrent signal reception including the initial 4 bit validity signal results in an output of the 24 bit identification number for display or processing.

Turning now to the second possible embodiment illustrated in Figures 2A and 2B, similar components of the circuits have been indicated by the same reference numerals as used in Figures IA and IB. The Figure 2 embodiment has been designed to allow control of the synchronisation by the interrogation apparatus 11 and avoid the need for accurate frequency determining devices within the identification device 10. In particular, the interrogation apparatus 11 includes energy transmitting means 12 for transmitting energy at a predetermined interrogate frequency, the identification device 10 being operative to generate an information signal comprising a carrier signal at an information

frequency. The information frequency is generated from the received interrogate frequency and in particular the information frequency is a sub-harmonic of the interrogate frequency.

When a bearer of the identificate device 10 shown in Figure 2A is to be identified or data concering the bearer or the device is to be read, the bearer approaches the identification station. The approach may be sensed and a proximity switching device of any suitable kind (e.g. capacitive, light beam, weight switch or the like) may be operable to initiate the information transfer operation. In particular, the proximity switching device may trigger the start circuit 60, which in turn applies power to the oscillator 20 operating at the interrogate frequency. The output of oscillator 20 is applied to power amplifier 21 which in turn supplies energy to the tuned antenna circuit 61 constituting the energy transmitting means 12. The antenna circuit 61 induces an alternating field in the region of the identification station, for example in a portal or the like through which the bearer of the identification device 10 is passing.

When the identification device 10 moves through the field generated by the antenna circuit 61, energy is induced in the inductance 62 of the energy collecting means 16. This inductance 62 is tuned by capacitor 63 to be resonant at the interrogate frequency generated by the energy transmitting means 12 thus attaining optimum power transfer from the energy transmitting means 12 to the identification device 10.

The voltage developed across the resonant circuit formed by inductance 62 and capacitance 63 is rectified by diode 34 so as to provide DC power for the circuitry of the identification device 10. The capacitor 64 filters the rectified voltage and provides and energy storage means 33 for the circuits of the identification device 10.

When the identification device 10 enters the field generated by the energy transmitting means 12 and receives the induced voltage, two responses occur. Firstly, the rectified voltage across capacitor 64 builds up and powers the circuits of the identification device 10. Application of this DC voltage to the reset generator 37 (such as a Schmitt trigger) causes a reset pulse or duration determined by capacitor 65 and resistor 66 to be applied so as to reset the divider 70 and the ripple counter 41. Secondly, the alternating voltage appearing across the energy collecting means 16 is coupled via capacitor 67 to a pulse shaping circuit 68 (e.g. a Schmitt trigger) operative to produce a rectangular wave form suitable for driving the dividers 70 and 71.

The divider 70 is operative to divide the signal at the interrogate frequency by a predetermined number to produce a suitable clock pulse train for the ripple counter 41. The ripple counter 41 may be, for example, a Johnson counter or other suitable encoder circuit. The counter 41 is operable to provide the data signal representing the information to be transmitted. The manner of providing the data signal on output line 44 may be substantially the same as described earlier in relation to counter 41 in Figure 1A. The data signal on line 44 is applied to gate 46.

The interrogate frequency signal from pulse shaping circuit 68 is also applied to divider 71 which is operative to divide the interrogate frequency by a small number to produce a carrier frequency signal on line 72.

Of course, with this method of producing the carrier frequency, the carrier frequency will be a sub-harmonic of the interrogate frequency. The carrier frequency signal on line 72 is applied to gate 46 so as to be modulated by the data signal on line 44 thereby producing a signal pulse train which is radiated by antenna 73 constituting the signal transmitter 32. Gate 12 may be a Schmitt trigger which is enabled and disabled by the data signal on line 44 and which is operative to generate square wave pulses at the carrier frequency, thereby producing an output signal having components at the carrier frequency and at sub-harmonics of the carrier frequency.

The signal receiver 13 is tuned to the carrier frequency which in turn is a synchronised sub-harmonic of the interrogate frequency. The received signal is amplified by a suitable low-noise amplifier 51 and fed to synchronous detector 80. A reference frequency signal for the synchronous detector 80 is developed by divider 81 which is fed with the interrogate frequency signal from the oscillator 20 and which divides the interrogate frequency signal by the same number as the divider 71 of the identification device 10, thus producing a synchronous carrier frequency on line 82.

The output of the synchronous detector 80 is a pulse train identical to that provided as the data signal on line 44 by the counter 41. This serial pulse train is applied to a first pulse detector 83 which enables register 84 only after the first pulse has been received. The subsequent serial pulses are converted to a parallel data group by the register 84 and applied to latch 85 which stores the data and allows it to be displayed by display device 57. The data can be held until the system is disabled or reset by the next bearer of an identification device initiating the start circuit 60.

The particular circuit arrangements shown in Figures 2A and 2B enable ready synchronisation of the various interrogator and identification device operating frequencies and also provide a degree of temperature variation immunity of the quality of the information transfer.

Referring now to the third embodiment illustrated in Figures 3A and 3B, the information transfer operation as in Figure 2 can be initiated by the approach of a bearer of an identification device 10. The start circuit 60 can be operable in response to detection of the approach of presence of a bearer of the device 10 to provide power for operation of the circuits of the interrogation apparatus 11.

The crystal oscillator 20 in Figure 3A may be operable at, say, 1.6 MHz and the output is divided by 8 in divider circuit 90, the output of which is coupled to the power amplifier 21. The resultant 200 KHz output is passed to loop antenna 15 constituting the energy transmitting means 12 so as to pro-

duce an electro-magnetic alternating field in the region of the identification station.

When exposed to the electro-magnetic field produced by the antenna 15, a voltage is induced in the resonant circuit 91 constituting the energy collecting means 16 of the identification device 10. The frequency is that determined by the crystal oscillator 20 and divider 90 (200 KHz).

The diode 34 rectifies the induced voltage to produce a DC voltage which is limited by zener diode 34 and stored by capacitor 33.

Schmitt trigger 37 produces a reset pulse determined by the RC combination 66,65 as in Figure 2. This reset pulse resets the dividers 70,71 and the counter 41 to their start conditions.

Schmitt trigger 68 shapes the wave form across the resonant circuit 91 to give a square wave at the interrogate frequency (200 KHz).

The interrogate frequency signal on line 93 is divided in divider 71 to produce a carrier frequency signal on line 72. In the illustrated embodiment, the divider 71 divides the interrogate frequency by 8 to provide the carrier frequency (25 KHz). This carrier frequency constitutes the fundamental carrier frequency of the identification device 10.

The interrogate frequency signal on line 93 is divided in the divider 70 to produce the clock frequency signal on line 38. In the illustrated embodiment, the divider 70 is operable to divide the interrogate frequency by 2^{14}, giving a clock frequency of about 12 Hz. The clock frequency signal is applied to the counter 41 constituting an encoder so that the encoder generates the preprogrammed identity signal in the manner described above in relation to Figure 1. The data signal generated by the encoder 41 is applied to line 44 and hence to Schmitt trigger 46 coupled to operate as a gate for modulating the carrier frequency signal on line 72. That is, the carrier freuqency signals on line 72 are gated by the data signal pulses on line 44.

The identification device in Figure 3A also includes a temperature sensor 100 for sensing a temperature associated with a bearer of the device, such as the body temperature of an animal. Temperature encoding means 101 are coupled to the temperature sensor 100 and are operative to generate a coded temperature signal on line 102, the coded temperature signal on line 102 being applied to the gate 46 so that the transmitted information signal includes information relating to the temperature sensed.

The particular temperature sensing arrangement in Figure 3A includes a temperature encoding means comprised by comparators 103, 104 connected to form a window comparator. The temperature sensor 100 comprises a thermal element 105 which, in use, is thermally coupled to the object or animal being monitored. The thermal element 105 is arranged to form one arm of each of a pair of resistive bridge networks 106,107 across which the comparators 103,104 are connected. Assuming that a standard temperature setting is 37°C, the higher comparator 103 or 104 may be operative to provide a signal if the temperature sensed by element 105 exceeds, say, 39°C. The other comparator 104 or 103 may then be operative to provide an output signal if the temperature sensed by element 105 exceeds, say, 35°C.

The outputs of the comparators 103,104 are coupled to gates 108,109 which are enabled by the last two output bits 110,111 of the encoder 41. With this arrangement, if the sensed temperature is below 35°C, no signal will be applied to line 102. If the sensed temperature is between 35°C and 39°C, one comparator will provide an output and an appropriate single pulse will be applied to line 102 through the appropriate one of the gates 108,109, that pulse being applied after the encoder has scanned along all its outputs and has thus generated firstly the identification data signal on line 44. If the sensed temperature is above 39°C, both comparators will provide outputs and two pulses will be applied to line 102 when encoder outputs 110,111 are sequentially supplied with a pulse. Thus, with this arrangement, the last two information bit locations of the information signal can carry the information as to whether the temperature sensed is below 35°C, is between 35°C and 39°C, or is above 39°C.

After the encoder 41 has scanned through the outputs enabling the identification data signal to be generated and the temperature information bits to be generated, the encoder 41 may be automatically inhibited by applying its last output terminal directly to an inhibit terminal 112. This will mean that the information signal is transmitted once and once only, thus avoiding repetition which might cause jamming in high traffic situations.

When the identification device 10 radiates the information signal from signal transmitter 32, that signal is in the form of bursts of energy at a fundamental information frequency of approximately 25KHz. The signal is also rich in harmonics because of the use of a Schmitt trigger 46 as the modulating gate, thereby giving usable information carrying signals at numerous sub-harmonics of the fundamental frequency.

The signal detected at signal receiver 13 are amplified in wide band low-noise amplifier 51 and applied to phase lock loop detectors 52 which are tuned to the fundamental carrier frequency and to sub-harmonics thereof.

The interrogate frequency from divider 90 of the energy transmitting part of the interrogation apparatus 11 is divided in divider 81 by 8 to provide carrier frequency synchronising pulses to logic circuit 55. Also, the interrogate frequency is applied through divider 120 which is operative to divide the interrogate frequency by 2^{14} to provide clock pulses synchronised to the clock pulses of the identification device 10. The logic circuit 55 is operative at previously described in relation to Figure 1B. For example, the output of the logic circuit may comprise the coded pulse train received from the phase lock loop detectors 52 having been verified by logic circuit 55, the code pulses being applied to register 121. The data in the register 121 may be passed to data processing facilities 22 for recording or other processing. Also, the data in register

121 can, if desired, be displayed at 57 for manual reading.

The circuit of Figures 3A and 3B transmits the information on a carrier frequency and sub-harmonics enabling ready verification of signal reception. Also, the circuits utilise the interrogate frequency to generate the carrier frequency thereby facilitating synchronisation and temperature independence of the information transfer operation.

More general advantages of the preferred embodiments described herein and illustrated in the drawings include:

(1) the ability to identify uniquely large numbers of items,

(2) identifiability of articles while moving along a path or corridor,

(3) identification of articles at a distance of 1 metre or more,

(4) independence of the identification device from internal power sources, although clearly the identification device could include a power source such as a chemical battery,

(5) capacity for integrating the system into an automated data processing system,

(6) ability to attach or implant identification devices in a wide variety of types of bearers (human, animal, inanimate).

Finally, it is to be understood that various alterations, modifications and/or additions may be made to the construction and arrangement of parts as herein described without departing from the scope of the present invention as defined in the appended claims.

CLAIMS

1. An information transmitting identification device presentable at an identification station to enable reception therefrom of information concerning the device or a bearer of the device, the identification device being usable with interrogation apparatus for initiating an information transfer operation, the interrogation apparatus including: energy transmitting means for transmitting energy in the region of the identification station, a signal receiver at the identif ication station for receiving from the identirication device an information signal comprising signal components, each signal component having a different respective frequency, the identification device including: energy collecting means operative to collect energy from the energy transmitting means and intercepted thereby in the region of the identification station and to generate an electrical power signal, information signal generating means operative to generate when energised from the electrical power signal an information signal comprising at least two carrier signals at respective predetermined carrier frequencies, each carrier signal being modulated in a coded way so as to be indicative of the information to be transmitted, and a signal transmitter operable to transmit the information signal to the signal receiver of the interrogation apparatus.

2. An identification device as claimed in claim 1 wherein said information signal generating means includes a carrier oscillator operable at a fundamental frequency, the carrier oscillator being arranged to be overdriven in use so as to generate a main carrier frequency signal at said fundamental frequency or at a harmonic of said fundamental frequency, and also so as to generate a further one of said at least two carrier signals at a sub-harmonic of said main carrier frequency.

3. An identification device as claimed in claim 1 wherein said information signal generating means includes a square wave generator operable at a fundamental frequency, said at least two carrier signals at said respective predetermined carrier frequencies comprising a main carrier frequency signal generated by said square wave generator and at least one secondary carrier frequency signal at a sub-harmonic of the carier frequency and also generated by said square wave generator, the main carrier frequency being equal to or being a sub-harmonic of the fundamental frequency of the square wave generator.

4. An identification device as claimed in claim 3 wherein the energy transmitting means is operative to transmit energy at a predetermined interrogate frequency and wherein said main carrier frequency is a sub-harmonic of said interrogate frequency.

5. An identification device as claimed in claim 4 wherein the information signa generating means includes dividing means for receiving a signal at said interrogate frequency from said energy collecting means, the dividing means being operative to divide the interrogate frequency so as to provide an output at the main carrier frequency and used to generate said carrier signals.

6. An identification device as claimed in any one of claims 1 to 5 wherein said information signal generating means includes gating means operative to gate said carrier signals to said signal transmitter, the pattern of gating constituting the coding of the information to be transmitted.

7. An information transfer apparatus including an information transmitting identification device as claimed in any one of claims 1 to 6 and an interrogation apparatus including energy transmitting means for transmitting energy in the region of the identification station, a signal receiver at the identification station for receiving said information signal from the identification device, the signal receiver including a plurality of detectors, each being operable at a respective one of said carrier frequencies, said signal receiver further including means coupled to said detectors and operative to indicate when a plurality of said detectors detect the simultaneous receipt of carrier signals modulated in the same coded way so as to be indicative of the same information having been simultaneously transmitted by the identification device at more than one said carrier frequency.

8. An information transmitting identification device presentable at an identification station to enable reception therefrom of information concerning the device or a bearer of the device, the identification device being usable with interrogation apparatus for initiating an information transfer operation,

the interrogation apparatus including: energy transmitting means for transmitting energy at a predetermined interrogate frequency in the region of the identification station, a signal receiver at the identification station for receiving from the identification device an information signal comprising a signal component having an information frequency, said information frequency being a sub-harmonic of said interrogate frequency, the identification device including: energy collecting means operative to collect energy from the energy transmitting means and intercepted thereby in the region of the identification station and to generate an electrical power signal, information signal generating means operative to generate when energised from the electrical power signal an information signal comprising a carrier signal at said information frequency, said carrier signal being modulated in a coded way so as to be indicative of the information to be transmitted, and a signal transmitter operable to transmit the information signal to the signal receiver of the interrogation apparatus.

9. An identification device as claimed in claim 8 wherein the information signal generating means includes dividing means for receiving a signal at said interrogate frequency from said energy collecting means, the dividing means being operative to divide the interrogate frequency so as to provide an output at said information frequency and used to generate said carrier signal.

10. An identification device as claimed in claim 8 or 9 wherein said information frequency comprises a main information frequency and said information signal generating means is also operative to generate at least one further carrier signal at a further information frequency, the or each said further information frequency being a sub-harmonic of said main information frequency, said at least one further carrier signal being modulated in a coded way so as to be indicative to the information to be transmitted, and said information signal comprising said carrier signal at said main information frequency and said at least one further carrier signal at said further information frequency.

11. An identification device as claimed in claim 10 wherein said information signal generating means includes a carrier oscillator operable at a fundamental frequency, the carrier oscillator being arranged to be overdriven in use so as to generate said carrier signal at said main information frequency, said main information frequency comprising said fundamental frequency or a harmonic of said fundamental frequency, and also so as to generate said at least one further carrier signal at a sub-harmonic or respective sub-harmonics of said main information frequency.

12. An identification device as claimed in claim 10 wherein said information signal generating means includes a square wave generator operable at a fundamental frequency, said information signal comprising said carrier signal at said main information frequency and being generated by said square wave generator and said at least one further carrier signal at said further information frequency which is a sub-harmonic of the main information frequency and also being generated by said square wave generator, the main information frequency being equal to or being a sub-harmonic of the fundamental frequency of the square wave generator.

13. An identification device as claimed in any one of claims 8 to 12 wherein said information signal generating means includes gating means operative to gate said carrier signal to said signal transmitter, the pattern of gating constituting the coding of the information to be transmitted.

14. An identification device as claimed in any one of the preceding claims wherein said information signal generating means includes a clock generator supplying a clock signal at a clock frequency and a counter coupled to receive the clock signal, the counter having a plurality of outputs which provide a signal sequentially at said dock frequency, a predetermined sequence and number of said outputs being connected to an output line so that a pulse train indicative of the particular sequence and number of connected outputs will be produced on said output line, said pulse train representing information to be transmitted.

15. An identification device as claimed in any one of the preceding claims wherein said energy transmitting means is operative to transmit energy in the region of the identification station for a predetermined time interval, said identification device including delay means coupled to the information signal generating means, the delay means being operative to inhibit operation of the information signal generating means until the end of said time interval.

16. An identification device as claimed in any one of the preceding claims and further including a temperature sensor for sensing a temperature associated with a bearer of the device and temperature encoding means coupled to the temperature sensor and operative to generate a coded temperature signal indicative of the temperature sensed, the coded temperature signal being applied to the information signal generating means so that the information signal includes information relating to the temperature sensed.

17. An identification device substantially as hereinbefore described with particular reference to any one of the accompanying drawings.

18. An information transfer apparatus including at least two information transmitting identification devilar reference to any one of the accompanying drawings.

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